ICESat (GLAS) Science Processing Software Document Series

Volume
GSAS Version Description
Version 2.2

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Foreword

This document contains the GLAS Science Algorithm Software (GSAS) Version Description document. This document is developed under the structure of the NASA STD-2100-91, a NASA standard defining a four-volume set of documents to cover an entire software life cycle. Under this standard a section of any volume may, if necessary, be rolled out to its own separate document. This document is a roll- out of the user guide within the Product Specification Volume.

The GEOSCIENCE LASER ALTIMETER SYSTEM (GLAS) is a part of the EOS program. This laser altimetry mission will be carried on the spacecraft designated EOS ICESat (Ice, Cloud and Land Elevation Satellite). The GLAS laser is a frequency-doubled, cavity-pumped, solid state Nd:YAG laser.

This document was prepared by the Observational Science Branch at NASA GSFC / WFF, Wallops Island, VA, in support of B. E. Schutz, GLAS Science Team Leader for the GLAS Investigation. This work was performed under the direction of David W. Hancock, III, who may be contacted at (757) 824-1238, hancock@osb.wff.nasa.gov (e-mail), or (757) 824-1036 (FAX).

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Section 1

Introduction

1.1 Identification of Document

This is the Version Description document for the Version 2.2 deliveries of the GLAS Science Algorithm Software (GSAS). The unique document identification number within the GLAS Ground Data System numbering scheme is TBD. Successive editions of this document will be uniquely identified by the cover and page date marks.

1.2 Scope of Document

The GLAS I-SIPS Data Processing System, shown in Figure 1-1, provides data processing and mission support for the Geoscience Laser Altimeter System (GLAS). I-SIPS is composed of two major software components - the GLAS Science Algorithm Software (GSAS) and the Scheduling and Data Management System (SDMS). GSAS processes raw satellite data and creates EOS Level 1A/B and 2 data products. SDMS provides for scheduling of processing and the ingest, staging, archiving and cataloging of associated data files. This document is the Version Description for the GSAS Version 2 delivery.

1.3 Purpose and Objectives of Document

The purpose of this document is to provide a precise description of the Version 2.2 delivery of GSAS.

1.4 Document Organization

This document's outline is assembled in a form similar to those presented in the NASA Software Engineering Program [Information Document 2.3a].

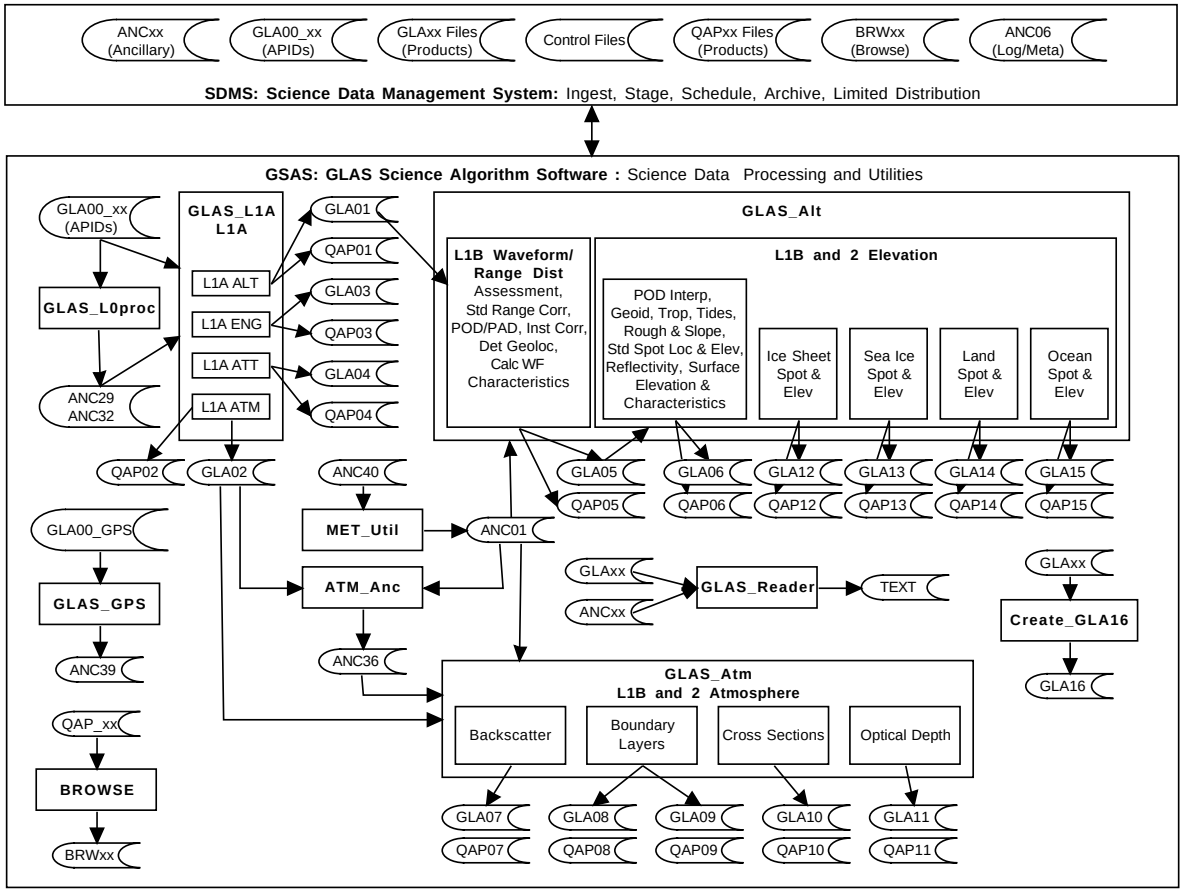

Figure 1-1 I-SIPS Software Top-Level Decomposition

1.5 Document Change History

Document Name: GLAS Science Algorithm Software Version Description		
Version Number	**Date**	**Nature of Change**
Version 0	July 1999	Original Version.
Version 1	November 2000	Revised for V1 software.
Version 2	November 2001	Revised for V2 software.
Version 2.2	July 2002	Revised for V2 software.

Section 2

Related Documentation

2.1 Parent Documents

Parent documents are those external, higher-level documents that contribute information to the scope and content of this document. The following GLAS documents are parent to this document.

a) *GLAS Science Software Management Plan* (GLAS SSMP), Version 3.0, August 1998, NASA Goddard Space Flight Center, NASA / TM-1999-208641 / VER3 / VOL1.

The GLAS SSMP is the top-level Volume 1 (Management Plan Volume) document of the four volumes of NASA software engineering documentation [Applicable Reference 2.2c]. It dictates the creation and maintenance of the Product Specification Volume (Volume 2). This document is a roll out of the Product Specification Volume.

2.2 Applicable Documents

a) NASA Software Documentation Standard Software Engineering Program, NASA, July 29, 1991, NASA-STD-2100-91.

b) GLAS Science Algorithm Software Detailed Design Document, Version 2.2, July 2002, NASA Goddard Space Flight Center.

c) GLAS Science Algorithm Software User's Guide, Version 2.2, July 2002, NASA Goddard Space Flight Center.

d) GLAS ISIPS Operational Procedures Manual, TBD.

2.3 Information Documents

a) GLAS Science Telemetry Packets Definition Document, Revision B, October 11, 2000, NASA Goddard Space Flight Center, GLAS-582-SPEC-002.

b) GLAS Standard Data Products Specification - Level 1, Version 4.0, November 2001, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DPS-2621.

c) GLAS Standard Data Products Specification - Level 2, Version 4.0, November 2001, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DPS-2641.

d) GLAS Science Data Management Plan (GLAS SDMP), Version 4.0, June 1999, NASA Goddard Space Flight Center Wallops Flight Facility, GLAS-DMP-1200.

e) Derivation of Range and Range Distributions From Laser Pulse Waveform Analysis for Surface Elevations, Roughness, Slope, and Vegetation Heights, Version 3.0, July 2000, NASA Goddard Space Flight Center, et al.

f) Precision Orbit Determination (POD), Version 2.1, February 2001, University of Texas Center for Space Research.

g) Precision Attitude Determination (PAD), Version 2.1, February 2001, University of Texas Center for Space Research.

h) Atmospheric Delay Correction to GLAS Laser Altimeter Range, Version 2.0, February 1999, NASA Goddard Space Flight Center, et al.

i) Ocean Tidal Loading Corrections, Version 1.0, February 1999, NASA Goddard Space Flight Center, et al

j) Laser Footprint Location (Geolocation) and Surface Profiles, Version 2.0, February 1999, NASA Goddard Space Flight Center, et al

k) Atmospheric Data Products, Version 2.0, February 1999, NASA Goddard Space Flight Center, et al

l) The Algorithm Theoretical Basis Document for Level 1A Processing, Version 0.2DRAFT, April 2001, NASA Goddard Space Flight Center / Wallops Flight Facility.

Section 3

Product Description

3.1 Purpose

GSAS generates the GLAS Standard Data Products and associated metadata describing the products and their quality. The software uses GLAS telemety and ancillary data to produce the products using algorithms defined by the GLAS Science Team.

GSAS is delivered as a set of libraries and executables (PGEs). The design and structure of GSAS is fully described in the GSAS Detailed Design Document.

Throughout this document, files are referenced as one of two types: GLA or ANC. GLA files are integer-binary format product files containing Level 0-2 GLAS science data. The GLA files are fixed-length binary files containing scientific measurements. GLA files are both input and output to GSAS. ANC files are multi-format ancillary files supplied by the science team which are required for processing. These files are detailed in the GLAS Data Management Plan and GLAS Standard Data Product Specifications Documents.

3.2 Environment

GSAS software is developed for and delivered on the UNIX platform. This document assumes that the reader is familiar with UNIX operating system conventions. The software is currently supported only on the HP / UX 11.0 operating system with Fortran 90 version v2.5.

3.3 Functions

The GSAS functions for V2.2 are:

- Read GLAS telemetry data and standard data products and ancillary files. Provide time-synchronization between product and ancillary files and between multiple products.
- Create all standard data products in an integer-binary format. These data products are grouped into the following categories:
  - Level-1A products. (GLA01-02)
  - Waveform products. (GLA05)
  - Atmosphere products. (GLA07-11)
  - Elevation products. (GLA06, GLA12-15)
- Perform selective processing based on input and output defined in a user-supplied control file.
- Creates EOS inventory metadata files.

- Maintain a full processing history.
- Report errors and messages in a standardized fashion with user-defined options available.
- Read changeable parameters from Science Team-supplied ancillary files.
- Convert product data into human-readable output.
- Create sample (but not scientifically accurate) test products.

3.4 Restrictions and Limitations

The V2.2 delivery of the GSAS has the following limitations:

- The software has the capability of processing many different scenarios. However, only tested scenarios are supported. These scenarios are:
  - One processing string to create all L1A products (GLA00 to GLA01-02).
  - One processing string that starts with an L1A altimetry product (GLA01) input to produce a waveform product (GLA05).
  - One processing string that starts with a waveform product (GLA05) input to produce all elevation products (GLA06, 12,13,14,15).
  - One processing string that starts with L1A atmosphere (GLA02) input and produces L2 atmosphere products (GLA07,08,09,10,11).
- GLA03, and the associated processing software, while referenced in documentation, is not present in the V2.2 delivery.
- GLA16, and the associated processing software, while referenced in documentation, is not present in the V2.2 delivery.
- Not all utility PGEs conform with GSAS standards regarding control files, file naming, error reporting, and processing history.
- GSAS core and utility PGEs may be run without error if all ANC07 files specified within the control file. Only specific ANC07 files are required for each PGE, but we have verified that specifying all does not cause an error. This capability was verified in order to avoid a potential SMDM limitation.
- GSAS will **not overwrite** existing files.The software will halt with a fatal error unless old output files are removed before execution.
- No process sanity checking is delivered in this version. This will be added in a later delivery.
- The GSAS is supported on HP / UX 11.0 with HP Fortran 90 compiler version 2.5.
- In a production environment, the GSAS would be controlled by the SDMS. The SDMS would produce control files, stage data, and control execution of the GSAS binaries. This document, however, is limited to GSAS and thus will not describe procedures within the scope of SDMS.

Section 4

Inventory and Product

4.1 Materials Released

Materials released include software code, documentation, static ancillary data and test data. These materials are delivered on physical media. Due to the size of ancillary and test data, a DLT tape shall be used as the distribution media. The documentation is delivered in form of Adobe PDF (Portable Document Format) files and, by request, hardcopy.

4.2 Product Content

To extract the GSAS Version 2.2 software, change to an appropriate directory (suggested at least 10GB available on the disk) and use the tar command to extract the software from distribution media.

When the tape is un-tarred, a gsas_v2.2 directory and several sub-directories will be created. Table 4-1 lists the top-level directories. describes the top-level directories.

Table 4-1 Top-level Content

Item	Description
bin	Directory where executables are stored.
cc_util	Make utilities.
data	Science-team provided static-ancillary files and sample control files.
docs	Documentation in PDF format.
lib	Directory where shared libraries are stored.
Makefile	Distribution Makefile.
src	Source code.
test	Sample products and testing area.

The bin and lib directories are delivered without content. They will be populated during the installation process. The remainder of this subsection describes content of the other directories.

4.2.1 Makefile utilities (cc_util)

This directory contains GSAS-standard makefile utilities. These files are used in GSAS makefiles and can be modified to change such things as compile-time options in a consistent manner.

Table 4-2 cc_util Content

Item	Description
cc_make_final.sh	Clearcase glue script to ease installation.
make_defs.	Symbolic link to make_defs.hp
make_defs.hp	HP-specific Makefile definitions.
make_defs.incl	Generic Makefile definitions.
make_depends.incl	Makefile dependencies.

4.2.2 Ancillary Data (data)

Initial versions of the science-team supplied ancillary data files as well as sample control files are included in this release. These files are located in the data directory of the tarfile and are designated Version 1.0.

Table 4-3 data Content

Item	Version	Description
anc07_001_00_00.dat	2.2	Error and Status file. Generated by development team.
anc07_001_00_01.dat	2.2	Global constants file. Generated by development team.
anc07_001_00_02.dat	2.2	Atmosphere constants file. Generated by development team.
anc07_001_00_03.dat	2.2	Elevation constants file. Generated by development team.
anc07_001_00_04.dat	2.2	Waveform constants file. Generated by development team.
anc07_001_00_05.dat	2.2	L1A constants file. Generated by development team.
anc07_001_00_06.dat	2.2	Utility constants file. Generated by development team.
anc12_001_00_00.dat	n/a	DEM header. Generated by development team from anc12_001_00_01.dat.
anc12_001_00_01.dat	n/a	DEM. From GTOPO30 (U.S. Geological Survey's EROS Data Center)
anc13_001_00_00.dat	n/a	Geoid. EGM96.
anc16_001_00_00.dat	n/a	Load Tide Model file. This was provided by the science team. SPOTL (Duncan Agnew -- SCRIPPS)
anc17_001_00_00.dat	n/a	Ocean Tide Model file. This was provided by the science team. GOT99.2 (Richard Ray -- GSFC)

Table 4-3 data Content (Continued)

Item	Version	Description
anc18_001_00_00.dat	n/a	Standard Atmosphere file. Standard Atmosphere profile file, in house. Pressure and temperature based on LOWTRAN radiative transfer program. Humidity based on Anderson, G. P., S. A. Clough, F. X. Kneizys, J. H. Chetwynd, and E. P. Shuttle, 1986: AFGL atmospheric constituent profiles (0-120 km), AFGL-TR-86-0110, 43 pp. [NTIS ADA175173]
anc30_001_00_00.dat	n/a	Global aerosol categorization map file. This was provided by the science team.
anc31_001_00_00.dat	n/a	Aerosol tropospheric classification map file. This was provided by the science team.

4.2.3 Documentation (docs)

The required delivery documentation for Version 2.2 is found in the docs directory. These documents are listed in Table 4-4

Table 4-4 docs Content

Item	Version	Description
atbd_waveform.pdf	3.0	ATBD - Derivation of Range and Range Distributions From Laser Pulse Waveform Analysis for Surface Elevations, Roughness, Slope, and Vegetation Heights
atbd_pod.pdf	2.1	ATBD - Precision Orbit Determination (POD)
atbd_pad.pdf	2.1	ATBD - Precision Attitude Determination (PAD)
atbd_tropo.pdf	1.0	ATBD - Atmospheric Delay Correction to GLAS Laser Altimeter Ranges
atbd_tide.pdf	1.0	ATBD - Ocean Tidal Loading Corrections
atbd_geolocation.pdf	2.0	ATBD - Laser Footprint Location (Geolocation) and Surface Profiles
atbd_atmos.pdf	2.0	ATBD - Atmospheric Data Products
atbd_l1a.pdf	0.2D	ATBD - Level 1A Processing
gsas_accept_test_v2.pdf	2.0	GSAS Acceptance Test Plan, Version 2.
gsas_ddesign_v2.pdf	2.0	GSAS Detailed Design Document, Version 2.
gsas_user_guide_v2.pdf	2.0	GSAS User's Guide, Version 2.
gsas_ver_desc_v2.pdf	2.0	GSAS Version Description, Version 2 (this document).
glas_prod_spec_1_v2.pdf	4.0	GLAS Standard Data Product Spec - Level 1
glas_prod_spec_2_v2.pdf	4.0	GLAS Standard Data Product Spec - Level 2

Table 4-4 docs Content

Item	Version	Description
glas_smp_v2.pdf	3.0	GLAS Science Software Management Plan
glas_dmp_v2.pdf	4.0	GLAS Data Management Plan
udf.tar	2.0	Tarfile snapshot of the Unit Development Folders.

4.2.4 Source (src)

Contents of the src directory are described in detail within the GSAS Detailed Design Document. Table 4-5 lists each major subdirectory and it's corresponding executable / library version number.

Table 4-5 src Content

Item	Version	Description
atm_lib	v2.2	Links atmosphere code into library structure.
atmosphere	v2.2	Development code for atmosphere code.
elev_lib	v2.2	Links elevation code into library structure.
elevations	v2.2	Development code for elevations code.
GLAS_L0proc	v2.2	GLAS L0 PGE
GLAS_L1A	v2.2	GLAS L1A PGE
GLAS_Atm	v2.2	GLAS Atmosphere PGE
GLAS_Alt	v2.2	GLAS Altimetry PGE
GLAS_GPS	v2.2	GLAS GPS processor
GLAS_Meta	v2.2	GLAS Metadata processor
met_util	v2.0	Met file Utility
atm_anc	v2.0	Atmosphere Utility
createGran_util	v2.0	Granule Utility
refOrbit_util	v2.0	Reference Orbit Utility
GLAS_Reader	v2.0	GLAS Reader Utility
lib	v2.0	Development shared library directory. (initially empty)
l1a	v2.0	<unused>
l1a_lib	v2.0	Development directory for L1A code
Makefile	v2.0	Master source Makefile
modules	v2.0	Development module directory. (initially empty.)
waveforms	v2.0	Development directory for waveforms code

Table 4-5 src Content (Continued)

Item	Version	Description
wf_lib	v2.0	Links Waveforms code into library structure.
common_libs/anc_lib	v2.0	Development directory for anc_lib.
common_libs/cntrl_lib	v2.0	Development directory for cntrl_lib.
common_libs/err_lib	v2.0	Development directory for err_lib.
common_libs/file_libt	v2.0	Development directory for file_libt.
common_libs/geo_libt	v2.0	Development directory for geo_libt.
common_libs/math_lib	v2.0	Development directory for math_lib.
common_libs/platform_lib	v2.0	Development directory for platform_lib.
common_libs/prod_lib	v2.0	Development directory for prod_lib.
common_libs/time_lib	v2.0	Development directory for time_lib.

4.2.5 Testing and Sample Products (test)

There are actually two distribution versions of GSAS 2.2. The deliveries are identical except for the content of the test directory. The internal delivery version contains test data and facilities as documented in the GSAS Acceptance Test Procedures. However, due to disk space and processing time requirements, external deliveries will have but a subset of the acceptance data and facilities. The content and usage of the test directory for external deliveries is documented in the GSAS Users Guide.

Section 5

Change Status

The Version 2.2 delivery of GSAS contains major changes from Version 2. The most important changes are changes to reflect updated ATBDs and new functionality provided by additional PGEs.

5.1 Installed Changes

5.1.1 Science Algorithms

Implemented changes defined in the latest version of the science algorithm ATBDs. These changes are documented in each respective ATBD. The latest ATBDs are available at:

http://www.csr.utexas.edu/glas/atbd.html

and

http://glas.wff.nasa.gov/docs (L1A).

The versions implemented in the V2.2 delivery are included as PDF files in the 'docs' directory of this distribution. The following table lists the version of each ATBD used for V2.2 development.

Table 5-1 ATBD Versions Implemented in V2.2

Title	Version
Derivation of Range and Range Distributions From Laser Pulse Waveform Analysis for Surface Elevations, Roughness, Slope, and Vegetation Heights	July 2000
Precision Orbit Determination (POD)	February 2001
Precision Attitude Determination (PAD)	February 2001
Atmospheric Delay Correction to GLAS Laser Altimeter Ranges	February 1999
Ocean Tidal Loading Corrections	February 1999
Laser Footprint Location (Geolocation) and Surface Profiles	February 1999
Atmospheric Data Products	Not yet released
The Algorithm Theoretical Basis Document for Level 1A Processing	May 2002

5.1.2 Data Products

Version 2.2 of the data products were implemented as described in the GLAS Standard Data Product Specifications - Level 1 and 2 and the respective ATBDs.

GLA01 and GLA02 data product formats were changed.

The content and description of the as-implemented Level 1 and 2 products is available at:

http://glas.wff.nasa.gov/v22_products

The content and description of the as-implemented Level 0 APID data is available at:

http://instra2.gsfc.nasa.gov/glas_doc/glas-582-spec-002e.pdf (science)

http://instra2.gsfc.nasa.gov/glas_doc/glas-582-spec-005c.pdf (engineering)

5.1.3 Data Product Headers

Full support for product headers is included. Metadata, as well as local product-specific information, is now stored in the product headers. Some local product-specific information is not fully implemented. NOSE support is not fully implemented.

5.1.4 GLAS_Meta

A new PGE, GLAS_Meta, was added to the delivery. This software reads ANC45 files and the associated product headers to create metadata files containing inventory-level metadata information.

5.1.5 GLAS_APID

A new PGE, GLAS_APID was written to create spreadsheet-compatible ASCII dumps of the raw APIDs. Currently, only APID19 is supported.

5.1.6 GLAS_L0proc

Cleaned up existing code to make it more maintainable. Modified the ANC32 file format. Provided support for additional APIDs. Several error checks were added to GLAS_L0proc.

5.1.7 GLAS_L1A

GLA01 and GLA02 formats and processing software was modified to support the new APID definitions. Support was added for L_Att processing. L_Atm processing was modified to work with new Atmosphere algorithms. Shottime calculation was rewritten for improved maintainability.

5.1.8 GLAS_Atm

Atmosphere algorithms were significantly re-written. Incorporated 2nd order least squares fit and modified calibration coefficient routine so that it is called each second by the manager. Added tolerance to times and adding indices to d_cal_time to fix IEEE underflow error for pr20020617-001. Added code for reduction of false positives. Eliminated cloud detection in aerosol detection routines. Significantly modified and enhanced optical properties algorithms.

5.1.9 GLAS_Alt Waveforms

Added maximum sigma, maximum amplitude, and along-track time interval for QA to anc07_001_01_04.dat. Assigned two bits of l_wfQual to indicate a poor fit (the fit parameters are no longer set to invalid for this case). Changed WFMgr,

W_CalcRelTime, and C_CalcNrg because of changes to GLA01. Revised QA processing.

5.1.10 GLAS_Alt Elevations

Added surface-type support to the elevation science algorithms.

5.1.11 atm_anc

Enhanced cloud search algorithm and added 532 and 1064 output to a file (ANC44) when a cloud is encountered above about 10 km. This will be used to try and calibrate the 1064 channel from the cloud returns

5.1.12 Externally-Deliverable Sample Product Readers

A set of externally-deliverable product readers was written. Each reader is independent of the others and of GSAS as a whole. A minimum number of routines was linked from the VOB to provide necessary support without requiring any GSAS libraries.

5.1.13 ANC Files

Several additional ancillary files and the requisite support software have been added. These include: ANC04, ANC45, and ANC38.

ANC24 was removed. ANC04 should be used in all control files where ANC24 was used previously.

Metadata Template Ancillary files (ANC45) are required when generating GLA products (the ANC45..01 metadata template file is required for GLA01, ANC45..02 for GLA02, etc.) and for creating metadata files.

Changes were made in all the ANC07 files. The format of ANC33 was changed. The format of ANC32 was changed.

5.1.14 Time Conversion Routine

Added a routine (j2000to19char_mod.f90) to the time library which converts time from J2000 UTC seconds into the format required for EOS metadata.

5.1.15 Modified POD/PAD Routines

Modifies the POD / PAD processing software to use new file formats and algorithms defined by UTCSR.

5.1.16 Pass-Thru Position Data

A new control file option was added to allow the algorithms to receive data from the Ancillary Science APID or from lower-level data products.

5.1.17 ANC07 Output in ANC06

New control file options were added to allow the ANC07 data to be written in the ANC06 file.

5.1.18 File version information in control file

GLA product FILE entries within the control file require the additional versioning information. The version attributes may be present on all INPUT_FILE and OUTPUT_FILE control lines, but are only required on the GLA OUTPUT_FILE entries.

5.1.19 PGE_Version Support

Each GSAS control file requires a PGE_VERSION entry.

5.1.20 PassID Support

The “cycle” and “pass” control file keywords were superseded by the “passid” keyword. A PASSID section is required in the control file when creating GLA products. There should be one instance of the PASSID for all tracks which fall within the minimum / maximum time of the data being processed. This information is required for GLAS_L1A, GLAS_Alt, and GLAS_Atm. This information is NOT required for GLAS_L0proc nor other utilities.

5.1.21 Keyword/Value Lengths

Maximum length for GSAS=standard keyword / value strings was expanded to 255 characters each.

5.1.22 Utilities

atm_anc, met_util, refOrbit_util, and createGran_util were updated.

5.1.23 Compiler Support

HP Fortran90 Version 2.5 is now the officially-supported compiler. The compiler update changed the arguments for the “getarg” intrinsic. GSAS is no longer compatible with previous versions of the HP Fortran90.

5.1.24 Compiler Options

The compiler flag options (+DAportable) which provided compatibility for earlier HP architectures has been removed from the Makefile include files.

5.1.25 Implemented PR/CRs

The software development team uses Change Requests (CR) and Problem Reports (PR) to identify problems in the software.Table 5-2 lists those PR / CRs implemented in GSAS 2.2.

Table 5-2 PR/CRs Implemented in Version 2.2

PR/CR	Short Description
CR20020306-001	APID_Av_Flg changes.
CR20020412-001	Energy unit changes for GLA01 and calibration coef changes.
CR20010423-002	Add VTCWp to ANC32.

Table 5-2 PR/CRs Implemented in Version 2.2 (Continued)

PR/CR	Short Description
CR20010831-001	Atmosphere modifications.
CR20011019-002	Add capacity to read all ANC07 files.
CR20020206-001	Process without predict orbit.
CR20020206-002	Process telemetry format 2.3+.
CR20020212-001	Change ANC07_001_01_01.dat to Improve Waveform Fitting.
CR20020213-001	Read_GLA00_Index overflows array.
CR20020226-001	Put correct Rmin and Rmax on the GLA01 data product.
CR20020227-001	GLA02 Missing pin.
CR20020227-002	Times output from create granule utility need to be in UTC not GPS.
CR20020301-001	Sanity Check ANC29 to GLA00.
CR20020301-002	ANC 32 file add oscillator
CR20020306-002	Would be nice if GLAS_L0proc wrote the start and stop time of APIDS in ANC06.
CR20020311-001	Remove i40_x_lid_flg from GLA02.
CR20020313-001	ANC09 Time synchronization.
CR20020403-001	Metadata parameters need to be changed.
CR20020403-001	Version_ID needs to be version of ESDT.
CR20020412-001	Changed units and calibration coefficients for energy parameters.
CR20020418-001	Aerosol/cloud module enhancements, post Release 2.1 software merge.
IPR20010907-001	Correctly initialize temporary variables.
PR20011105-001	Removed waveform manager controls.
PR20011204-001	Modifications to met_util.
PR20020206-003	GLOP has an ANC32 creation error.
PR20020208-001	Parameter overflow in product file.
PR20020213-001	GLA00_index bounds checking.
PR20020304-001	Time of the first shot was not calculated correctly if there was an invalid prelim range.
PR20020315-001	Allow for opening of multiple ANC24 files (rot matrix).
PR20020321-001	GLA10 P2A checks product fields against wrong invalid constant.
PR20020411-002	Do not synchronize ReadData with ANC09.
PR20020426-001	Compile failures.

Table 5-2 PR/CRs Implemented in Version 2.2 (Continued)

PR/CR	Short Description
PR20020509-001	GLA01 i_rng_wf invalidity flag documentation.
PR20020510-001	Core dump while running Elevation Manager for MOSS7.
PR20020510-002	"Bus Error/Error while unwinding stack" while running waveforms, glas_atm, and atm_anc on ISIPSPR1.
PR20020516-001	WF QA incorrectly assumes exactly 1 second between records.
PR20020516-002	When using pass-thru position, lat/lon is invalid on GLA05.
PR20020516-003	c_getregions overflows array bounds when longitude is exactly 180.0 deg.
CR20020522-002	Add Max Values For Amplitude and Sigma to anc07 and Change Handling of NoFits
PR20020604-001	Modify getarg argument in utilities.
PR20020617-001	Time tolerance for comparing ANC36 and GLA02 times.
PR20020627-001	anc18_stdatm_mod and atm_anc need format changes.
PR20020702-001	GLA04 meta data file.

5.2 Waivers

- Not all scenarios specified in the Requirements document are tested.
- GLA03 support is not delivered.
- GLA04 support is not delivered.
- GLA16 support is not delivered.
- Precision time calculation when GPS is not present is not yet coded.
- Sub-APID time alignment for LPA/GPS is not implemented.
- Several PR/CRs have been suspended for a later version.

5.3 Possible Problems and Known Errors

Table 5-3 lists the PRs and CRs open for V2.2. These will be corrected in a later delivery.

Table 5-3 Open or Suspended PR/CRs in Version 2.2

PR/CR	Short Description
CR20020301-001	Sanity Check ANC29 to GLA00.
CR20020409-001	Global variable gi_fname_len needs to be made larger.
CR20020411-001	Move anc file open code from openfiles to read_anc.

Table 5-3 Open or Suspended PR/CRs in Version 2.2 (Continued)

PR/CR	Short Description
CR20020418-002	GLA08, GLA09 enhancements, post Release 2.1 software merge.
CR20020507-001	Frequency board time conversion to use oscillator.
CR20020507-002	Transit time and ranges must be corrected for oscillator drift.
CR20020510-003	L1A check on waveform status.
CR20020522-002	Add Max Values For Amplitude and Sigma to anc07 and Change Handling of NoFits.
IPR20020301-003	GL0P startup problem.
PR20020423-001	Input files should be listed in products.
PR20020506-001	Error in Calculation of Preliminary Uncorrected Lat, Long, Elev, and Range Offsets in GLA05.
PR20020510-004	Cloud peak, ground ret and grn bin.
PR20020514-001	Need better check for start of processing in managers.

5.4 Requirements Not Supported in the V2 Delivery

Requirements from the GLAS Science Software Requirements Document that are not supported in the V2 delivery of the I-SIPS software are shown in Table 5-4.

Table 5-4 Requirements Not Supported

Requirements Number	Description	Status
GSDP-30100	The I-SIPS Software will create GLAS standard products that are to be delivered to the DAAC in the format agreed to by ESDIS.	original
GSDP-31300	Automatic or manual Quality Assurance (QA) is provided for each standard data product and ancillary file. Until QA is completed, the file shall be marked as invalidated. Upon successful completion of QA, the file shall be marked as validated.	original

5.5 Changed Files

```
/glas/vob/Makefile
/glas/vob/cc_util/make_defs.hp
/glas/vob/data/anc07_001_01_00.dat
/glas/vob/data/anc07_001_01_01.dat
/glas/vob/data/anc07_001_01_02.dat
/glas/vob/data/anc07_001_01_04.dat
/glas/vob/data/anc07_001_01_05.dat
```

```
/glas/vob/data/anc07_001_01_06.dat
/glas/vob/src/Makefile
/glas/vob/src/atm_anc/A_common_mod.f90
/glas/vob/src/atm_anc/A_prod_reader_mod.f90
/glas/vob/src/atm_anc/A_read_control_mod.f90
/glas/vob/src/atm_anc/A_seg_cal_cofs_mod.f90
/glas/vob/src/atm_anc/A_sum_lidar_mod.f90
/glas/vob/src/atm_anc/atm_anc.f90
/glas/vob/src/atm_lib/Makefile
/glas/vob/src/atmosphere/QA/A_qa_stats_mod.f90
/glas/vob/src/atmosphere/backscat/A_bscs_mod.f90
/glas/vob/src/atmosphere/backscat/A_cal_cofs_mod.f90
/glas/vob/src/atmosphere/backscat/A_rebin_lid_mod.f90
/glas/vob/src/atmosphere/common/A_buff_data_mod.f90
/glas/vob/src/atmosphere/interp/A_interp_met_mod.f90
/glas/vob/src/atmosphere/layers/A_20s_aer_det_mod.f90
/glas/vob/src/atmosphere/layers/A_4s_aer_det_mod.f90
/glas/vob/src/atmosphere/layers/A_cld_lays_mod.f90
/glas/vob/src/atmosphere/layers/A_pbl_det_mod.f90
/glas/vob/src/atmosphere/layers/A_pbl_lay_mod.f90
/glas/vob/src/atmosphere/opt_props/A_aer_opt_prop_mod.f90
/glas/vob/src/atmosphere/opt_props/A_cld_opt_prop_mod.f90
/glas/vob/src/atmosphere/opt_props/A_opt_thin_mod.f90
/glas/vob/src/common_libs/Makefile
/glas/vob/src/common_libs/anc_lib/ANC07_mod.f90
/glas/vob/src/common_libs/anc_lib/Makefile
/glas/vob/src/common_libs/anc_lib/anc04_quat_mod.f90
/glas/vob/src/common_libs/anc_lib/anc07_atm_mod.f90
/glas/vob/src/common_libs/anc_lib/anc07_elev_mod.f90
/glas/vob/src/common_libs/anc_lib/anc07_l1a_mod.f90
/glas/vob/src/common_libs/anc_lib/anc07_wf_mod.f90
/glas/vob/src/common_libs/anc_lib/anc08_pod_mod.f90
/glas/vob/src/common_libs/anc_lib/anc25_gpsutc_mod.f90
/glas/vob/src/common_libs/anc_lib/anc29_index_mod.f90
/glas/vob/src/common_libs/anc_lib/anc32_gps_mod.f90
/glas/vob/src/common_libs/anc_lib/anc33_utc_mod.f90
/glas/vob/src/common_libs/anc_lib/anc36_atm_mod.f90
/glas/vob/src/common_libs/anc_lib/vers_anc_mod.f90
/glas/vob/src/common_libs/cntrl_lib/Makefile
/glas/vob/src/common_libs/cntrl_lib/compare_kval_mod.f90
/glas/vob/src/common_libs/cntrl_lib/fStruct_mod.f90
/glas/vob/src/common_libs/cntrl_lib/keyval_mod.f90
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/glas/vob/src/common_libs/err_lib/ErrDefs_mod.f90
/glas/vob/src/common_libs/err_lib/ErrorBoot_mod.f90
/glas/vob/src/common_libs/err_lib/vers_err_mod.f90
/glas/vob/src/common_libs/exec_lib/CntlDefs_mod.f90
/glas/vob/src/common_libs/exec_lib/MainInit_mod.f90
/glas/vob/src/common_libs/exec_lib/MainWrap_mod.f90
/glas/vob/src/common_libs/exec_lib/Makefile
/glas/vob/src/common_libs/exec_lib/OpenFiles_mod.f90
/glas/vob/src/common_libs/exec_lib/ReadAnc_mod.f90
/glas/vob/src/common_libs/exec_lib/ReadData_mod.f90
/glas/vob/src/common_libs/exec_lib/StdCntl_mod.f90
/glas/vob/src/common_libs/exec_lib/com_hdr_update_mod.f90
/glas/vob/src/common_libs/exec_lib/fCntl_mod.f90
/glas/vob/src/common_libs/exec_lib/get_fileindex_mod.f90
/glas/vob/src/common_libs/exec_lib/parse_filecntl_mod.f90
/glas/vob/src/common_libs/exec_lib/vers_exec_mod.f90
```

```
/glas/vob/src/common_libs/file_lib/Makefile
/glas/vob/src/common_libs/file_lib/vers_file_mod.f90
/glas/vob/src/common_libs/geo_lib/vers_geo_mod.f90
/glas/vob/src/common_libs/math_lib/Makefile
/glas/vob/src/common_libs/math_lib/vers_math_mod.f90
/glas/vob/src/common_libs/platform_lib/const_atm_mod.f90
/glas/vob/src/common_libs/platform_lib/const_glob_mod.f90
/glas/vob/src/common_libs/platform_lib/const_l1a_mod.f90
/glas/vob/src/common_libs/platform_lib/const_wf_mod.f90
/glas/vob/src/common_libs/platform_lib/vers_platform_mod.f90
/glas/vob/src/common_libs/prod_lib/GLA00_alg_mod.f90
/glas/vob/src/common_libs/prod_lib/GLA00_mod.f90
/glas/vob/src/common_libs/prod_lib/GLA00_print_mod.f90
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/glas/vob/src/common_libs/prod_lib/conversions_mod.f90
/glas/vob/src/common_libs/prod_lib/prod_def_mod.f90
/glas/vob/src/common_libs/prod_lib/vers_prod_mod.f90
/glas/vob/src/common_libs/time_lib/Makefile
/glas/vob/src/common_libs/time_lib/vers_time_mod.f90
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/glas/vob/src/createGran_util/pop_granule_mod.f90
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/glas/vob/src/elevations/c_calcsploc_mod.f90
/glas/vob/src/elevations/c_intrppod_mod.f90
/glas/vob/src/elevations/c_legacyintrppod.f90
/glas/vob/src/glas_alt/ElevMgr_mod.f90
```

```
/glas/vob/src/glas_alt/GLAS_Alt.f90
/glas/vob/src/glas_alt/GetControl_mod.f90
/glas/vob/src/glas_alt/WFMgr_mod.f90
/glas/vob/src/glas_atm/AtmMgr_mod.f90
/glas/vob/src/glas_atm/GLAS_Atm.f90
/glas/vob/src/glas_atm/GetControl_mod.f90
/glas/vob/src/glas_l0p/GLAS_L0proc.f90
/glas/vob/src/glas_l0p/glop_mod.f90
/glas/vob/src/glas_l0p/gps_index.h
/glas/vob/src/glas_l0p/index_grouping_mod.f90
/glas/vob/src/glas_l0p/time_conversion_mod.f90
/glas/vob/src/glas_l1a/GLAS_L1A.f90
/glas/vob/src/glas_l1a/GetControl_mod.f90
/glas/vob/src/glas_l1a/L1AMgr_mod.f90
/glas/vob/src/glas_l1a/WriteL1A_mod.f90
/glas/vob/src/glas_reader/GLAS_Reader.f90
/glas/vob/src/glas_reader/GetControl_mod.f90
/glas/vob/src/glas_reader/Makefile
/glas/vob/src/glas_reader/PrintAnc_mod.f90
/glas/vob/src/glas_reader/PrintData_mod.f90
/glas/vob/src/l1a_lib/C_CalcNrg_mod.f90
/glas/vob/src/l1a_lib/L_ALTQA_mod.f90
/glas/vob/src/l1a_lib/L_Alt_mod.f90
/glas/vob/src/l1a_lib/L_Atm_mod.f90
/glas/vob/src/l1a_lib/L_Att_mod.f90
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/glas/vob/src/prod_util/product_test/gla00_reader.f90
/glas/vob/src/prod_util/product_test/gla01_minmax_mod.f90
/glas/vob/src/prod_util/product_test/gla01_reader.f90
/glas/vob/src/prod_util/product_test/gla01_writer.f90
/glas/vob/src/prod_util/product_test/gla02_minmax_mod.f90
/glas/vob/src/prod_util/product_test/gla02_reader.f90
/glas/vob/src/prod_util/product_test/gla02_writer.f90
/glas/vob/src/prod_util/product_test/gla03_minmax_mod.f90
/glas/vob/src/prod_util/product_test/gla03_reader.f90
/glas/vob/src/prod_util/product_test/gla03_writer.f90
/glas/vob/src/prod_util/product_test/gla05_minmax_mod.f90
/glas/vob/src/prod_util/product_test/gla05_reader.f90
/glas/vob/src/prod_util/product_test/gla05_writer.f90
/glas/vob/src/prod_util/product_test/gla06_minmax_mod.f90
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/glas/vob/src/prod_util/product_test/gla09_minmax_mod.f90
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/glas/vob/src/prod_util/product_test/gla10_minmax_mod.f90
/glas/vob/src/prod_util/product_test/gla10_reader.f90
/glas/vob/src/prod_util/product_test/gla10_writer.f90
```

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/glas/vob/src/prod_util/product_test/gla11_minmax_mod.f90
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/glas/vob/src/prod_util/product_test/gla11_writer.f90
/glas/vob/src/prod_util/product_test/gla12_minmax_mod.f90
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/glas/vob/src/waveforms/W_Common/W_LsqFit_mod.f90
/glas/vob/src/waveforms/W_Common/W_Types_mod.f90
/glas/vob/src/waveforms/W_CreQAStats/W_CreQAStats_mod.f90
/glas/vob/src/waveforms/W_FunctionalFt/W_FunctionalFt_mod.f90
```

Abbreviations & Acronyms

EOS	NASA Earth Observing System Mission Program
EOSDIS	Earth Observing System Data and Information System
GLAS	Geoscience Laser Altimeter System instrument or investigation
GSFC	NASA Goddard Space Flight Center at Greenbelt, Maryland
GSFC/WFF	NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia
ID	Identification
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
POD	Precision Orbit Determination
TBD	to be determined, to be done, or to be developed
UNIX	the operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division

Glossary

aggregate	A collection, assemblage, or grouping of distinct data parts together to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.
array	An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.
file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file. Loosely employed it is used to indicate a collection of GLAS data records without a standard label. For the Level 1A Data Product, the file would constitute the collection of one-second Level 1A data records generated in the SDPS working storage for a single pass.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
item	Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A standard label may imply a standard data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.

Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.
Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and georeference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS ALT-L spacecraft each orbit starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
module	A collection of program statements with four basic attributes: input and output, function, mechanics and internal data.
pass	A sub-segment of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator; for GLAS the pass is identified as either the northern or southern hemisphere portion of the ground track on any orbit
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the SDPS or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate a single pass file aggregation, or the entire set of product files contained in a data repository.
program	The smallest set of computer instructions that can be executed as a standalone unit
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
Scenario	A single execution path for a process.

Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS ALT-L/ GLAS Data Product produced on the EOSDIS SDPS for GLAS data product generation or within the GLAS Science Computing Facility using EOS science community approved algorithms. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
Subroutine	A program that is called by another program
variable	Usually a reference in a computer program to a storage location, i.e., a place to contain or hold the value of a data item.